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PICATINNY ARSENAL

TECHNICAL GROUP

CHEMICAL DEPARTMENT

TECHNICAL REPORT

SERIAL NO. 1188

DATE August 14, 1942

SUBJECT: SPECIAL TESTS OF SENSITIVITY OF TNT

THIRD PROGRESS REPORT

1683

SYNOPSIS

The deposition of finely-divided TNT in fume-ducts above TNT melting units has raised question as to whether such material represents a special hazard due to increased sensitivity.

It has been found that condensed TNT consists of accretions of very small plates; and while it is more sensitive to impact and initiation than ordinary, crystalline TNT, it is less sensitive than tetryl. Its greater sensitivity than ordinary TNT is considered to be due to its fine state of subdivision. While more susceptible to decomposition by light than ordinary TNT, condensed TNT does not become markedly more sensitive to impact in the course of such decomposition. However, either condensed or crystalline TNT which has been decomposed by light is distinctly more sensitive than ordinary, crystalline TNT.

It is concluded that condensed TNT represents an increased hazard as compared with that of ordinary, crystalline TNT.

(14) IA TR-11..

No. 1188
Picatinny Arsenal, ~~Dover~~, N.J.,
(11) 14 Aug[redacted] [redacted]42

(12) 9p.

TECHNICAL GROUP
CHEMICAL DEPARTMENT
CHEMICAL LABORATORIES DIVISION

(6) Special Tests of Sensitivity of
TNT.

(9) [redacted] PROGRESS REP[redacted]T, no. 3.

INTRODUCTION:

1. In the melt-loading of TNT and 50-50 Amatol, deposits of finely divided TNT tend to accumulate in the ventilating ducts above the TNT melting units because of condensation of TNT vapor. It has been suggested that the condensed TNT may represent a hazard because of the fineness of the material and because it might also represent a concentration of impurities in the TNT more sensitive than the TNT itself.

2. It was considered desirable to prepare such material and make a study of its explosive properties in order to determine if it represents any special hazard.

OBJECT:

3. To prepare a quantity of condensed TNT and determine its explosive and chemical properties.

RESULTS:

4. Approximately 15 grams of condensed TNT was prepared by heating portions of Lot DP 2325 on a steam bath and condensing the vapor. A photomicrograph of the material at 120 X (M-12796) shows this to consist of colorless,needle-like pseudo crystals representing accretions of thin plates.

5. Tests of the condensed TNT and of the TNT from which it was prepared gave the following data:

282 901

	Condensed TNT As Prepared	Condensed TNT Melted and ground[a]	Standard TNT, Lot DP 2325
Melting point, °C.	81.09		80.69
Setting point, °C.			80.45
Min. temp. to cause instant explosion, °C.	580		580
Drop test, 2 Kg.Wt.			
PA apparatus, inches	10	13	14
Bur. Mines apparatus, cm.	40	92	100
Min. detonating charge, gm. fulminate	0.22	0.25	0.24
Sand test, gms. sand crushed	42.0		41.4

[a] Ground to pass through No. 100 sieve.

6. When thin layers of condensed and standard TNT were exposed to ultra-violet light, melting point and sensitivity to impact determinations yielded the following data:

Hours of Exposure	Condensed TNT M.P., °C.	Condensed TNT Drop Test, cm.	Standard TNT M.P., °C.	Standard TNT Drop Test, cm.
0	81.09	40	80.69	100
0.25	80.94		80.52	
0.5	80.88		80.48	
1.0	80.78		80.48	
2.5	80.48		80.33	
4.0	80.38		80.31	
6.5	80.30		80.30	
10.5	80.13		80.13	
20	79.95		79.95	
26	79.79		79.89	
45	79.63		79.89	
75	79.60	37	79.89	44
175	79.45	39	79.80	47

At the end of these tests each sample had become brown in color.

DISCUSSION OF RESULTS:

7. Photomicrograph M-12796 shows condensed TNT to have a structure very different from that of standard TNT, which ordinarily consists of monoclinic crystals. The photomicrograph shows the condensed TNT to consist of needle-like accretions of plates much smaller than the ordinary crystals of TNT.

8. It was thought that condensed TNT might be impure and sensitive, due to the concentration of volatile impurities in the TNT from which it was derived. The melting point data show that the condensed TNT is even purer than the TNT from which it was prepared, the melting point of the condensed TNT being 0.4°C. higher than the standard TNT. Insufficient condensed TNT was available for a setting point determination, but if the difference (0.24°C.) between the melting point and setting point values for the standard TNT is applied to the condensed TNT, this has a calculated setting point value of 80.85°C. This is 0.10°C. higher than any recorded setting point value for chemically pure TNT, and would indicate that the condensed TNT is at least as pure as any TNT of which there is record in the literature. Any unusual characteristics of condensed TNT, therefore, cannot be ascribed to the presence of impurities.

9. In the Explosion Temperature Test a small portion of the sample is placed in an empty No. 8 detonator shell and this is immersed in a bath of molten metal at a measured temperature, the time required to cause explosion being noted and the temperature varied until the material explodes in 5 seconds. TNT melts at 81°C. and requires a minimum temperature of 470°C. to cause explosion in 5 seconds; and this test could not be used to differentiate between condensed TNT and ordinary crystalline TNT with respect to thermal sensitivity, since the melting of each would destroy the difference in physical structure before the explosion temperature is attained. When the two forms of TNT were tested by determining the minimum temperature of molten metal required to cause instantaneous explosion when particles were dropped on the surface of the molten metal, it was found that each exploded when the temperature was 580°C. or greater. The condensed TNT, therefore, is indicated by this test to be no more susceptible to explosion by heat than ordinary TNT.

10. Drop Tests with both the standard PA and Bureau of Mines apparatus showed the condensed TNT to be distinctly more sensitive to impact than standard TNT. When a portion of the condensed TNT was melted, solidified, and ground to a fine powder, this had Drop Test values closely approximating standard TNT. Similarly, the condensed TNT was distinctly more sensitive to initiation by mercury fulminate than standard TNT, but the sensitivity of the condensed TNT after melting and grinding was no greater than that of standard TNT. These results show that the greater sensitivity of condensed TNT, as compared with that of standard TNT, is due to the difference in physical structure between the two. The large number of cleavage planes represented by the surfaces of the adjoining plates of condensed TNT, which generally are parallel to each other, probably results in the development of greater internal friction when the material is subjected to impact. In standard TNT the growth of regular crystals results in relatively few inter-crystalline planes and these at various angles to each other. The difference in sensitivity to initiation between condensed and standard TNT may be ascribed to the much greater specific surface of condensed TNT.

11. Although condensed TNT is definitely more sensitive to impact and initiation than standard TNT, it cannot be considered extremely sensitive. It is less sensitive to impact and initiation than tetryl (26 cm. and 8-inch Drop Test values and 0.19 gm. of mercury fulminate). In view of this and the fact that condensed TNT is no more thermally sensitive than standard TNT, condensed TNT cannot be considered to represent an extreme hazard.

12. Recognizing that the greater specific surface of condensed TNT, as compared with that of standard TNT, should render it more reactive as well as sensitive, a sample of each in the form of a thin layer was subjected to the action of ultra-violet light. The sample was mixed daily to insure uniformity of action, and melting point and Drop Test determinations were made at intervals. The data given under Results show that at the end of 75 hours of exposure, the purity of condensed TNT was reduced almost twice as much as that of standard TNT, as judged by the decreases in their melting point values (1.49° and 0.80°C.). The sensitivity to impact of the condensed TNT was increased very slightly, but that of the standard TNT was increased to approximately that of the condensed TNT. It is thought that, in addition to some chemical decomposition, one of the effects of ultra-violet light on standard, crystalline TNT may have been the cleavage and disintegration of the crystals to form minute particles of greater sensitivity to impact.

13. The very slight increase in the sensitivity of condensed TNT after exposure to and partial decomposition by ultra-violet light indicates that although it is more susceptible to decomposition by light than ordinary TNT, it does not become especially sensitive even when decomposed to such an extent that it no longer complies with the purity (setting point) requirement for Grade I TNT. From a practical viewpoint, the greater sensitivity of condensed TNT than crystalline TNT should be recognized as representing some increased hazard and accumulations of such material should be prevented so far as is practicable.

CONCLUSIONS:

14. Finely-divided, condensed TNT is intermediate between standard, crystalline TNT and tetryl with respect to sensitivity to impact and initiation. Although it is more susceptible to decomposition by light than crystalline TNT, the sensitivity to impact of condensed TNT after exposure to light is not markedly different from that of ordinary TNT after being subjected to the same exposure.

RECOMMENDATIONS:

15. It is recommended that the accumulation of condensed TNT and of TNT which has been exposed to light for a prolonged period be avoided so far as practicable.

EXPERIMENTAL PROCEDURE:

16. Melting point determinations were made with a thermometer calibrated by the U.S. Bureau of Standards. Setting point, Drop Test, and Sand Test determinations were made by the procedure standard at this Arsenal. The minimum temperature required to cause instantaneous explosion was determined by dropping individual small crystals or tiny particles of TNT on the surface of a bath of molten Wood's metal, the temperature of which was measured by means of a calibrated thermocouple, the junction of the thermocouple being immersed in the molten metal.

17. Condensed TNT for test was prepared by heating molten TNT on a steam bath in a glass crystallizing dish. Superimposed on the crystallizing dish was a round-bottomed evaporating dish. The vapors of TNT condensed on the bottom of the evaporating dish and were scraped off.

18. The effect of ultra-violet light was determined by spreading a 1-gram sample in a thin layer and placing this under an ultraviolet lamp. The TNT was mixed and respread at least once daily.

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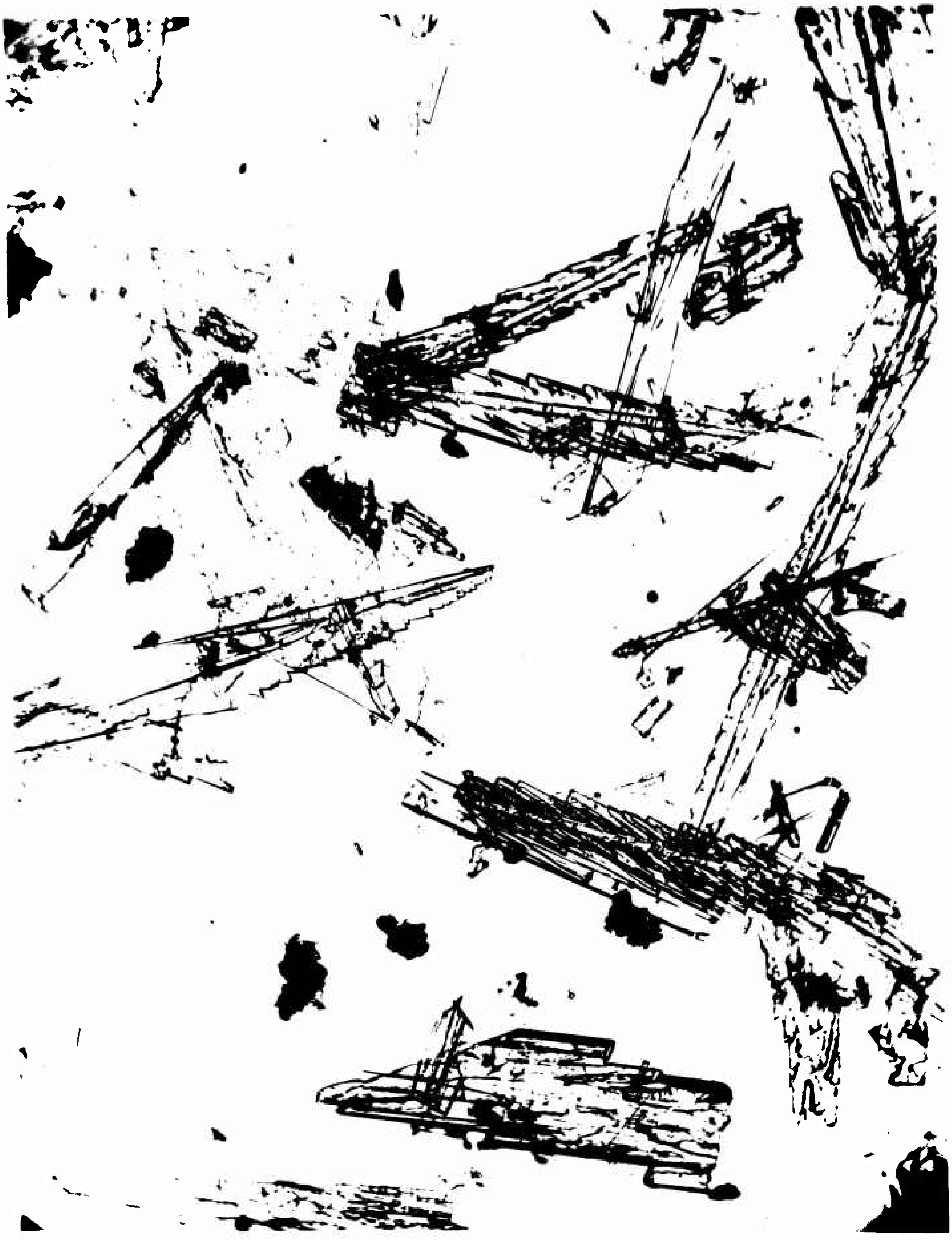

M-12796 March, 1942 PICATINNY ARSENAL ORDNANCE DEPARTMENT

Condensed TNT - 120X

M-13902 August, 1942 PICATINNY ARSENAL ORDNANCE DEPARTMENT

T.N.T. Lot DP2325 - 110X